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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/887,877	06/21/2001	Donald Brian Eidson	01827.0037.CPUS01	9000

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EXAMINER	
CHAUDRY, MUJTABA M	

ART UNIT	PAPER NUMBER
2133	

DATE MAILED: 03/04/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/887,877	EIDSON ET AL.	
	Examiner	Art Unit	
	Mujtaba K Chaudry	2133	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 June 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-59* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-41,44 and 56-58* is/are rejected.

7)☒ Claim(s) *42,43,45-53 and 59* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 June 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *03/12/2002*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

The drawings are objected to because:

Figure 1A:

- Figure 1A should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
- Reference block 3 needs to be labeled.

Figure 1B:

- Figure 1B should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 1C:

- Figure 1C should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 1C, reference number 15. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 3A:

- Reference block 25 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 3A, reference number 26. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 3B:

- Reference block 31 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 3B, reference numbers 29a, 29b, 33 and 32. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the

description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 4:

- Reference block 37 needs to be labeled.

Figure 5:

- Reference block 42 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 5, reference numbers 41a, 41b, 41c, 39d and 43. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 6:

- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 6, reference number 52. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Figure 7A:

- Reference block needs to be labeled.

Figure 8A:

- Reference block needs to be labeled.

Figure 9A:

- Reference block needs to be labeled.

Figures 9B, 10 and 16:

- Figures are off center and need to be centered.

Figure 11B:

- Reference blocks 61a-c needs to be labeled.

Figure 11C:

- Reference blocks 61 needs to be labeled.

Figure 15:

- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 15, reference number 200. A proposed drawing correction, corrected drawings, or

amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

The disclosure is objected to because of the following informalities:

- Applicant is reminded that reference numbers pointed out above in the drawing objections need to appear in the specification.

Appropriate correction is required.

Claim Objections

- Claim 40 is objected to because the dependency is not in the preamble of the claim.
- Claim 41 is objected to because the dependency is not in the preamble of the claim.
- Claim 42 is objected to because the dependency is not in the preamble of the claim.
- Claim 42 is objected to because of multiple dependency.
- Claim 45 is objected to because of multiple dependency.
- Claim 49 is objected to because of multiple dependency.
- Claims 50-53 are objected to because of "..the combination of..." in the preamble.
- Claim 56 is objected to because the dependency is not in the preamble of the claim.

- Claim 57 is objected to because the dependency is not in the preamble of the claim.
- Claim 58 is objected to because the dependency is not in the preamble of the claim.
- Claim 59 is objected to because the dependency is not in the preamble of the claim.
- Claim 59 is objected to because of multiple dependency.

The Examiner would like to point out that Claims **42, 45, 49, 50-53 and 59** are objected to under 37 CFR 1.75(c) as being in improper form because of multiple dependency. See MPEP § 608.01(n). For example, Claim 42 recites, "...any of **claims 40 or 41**..." [Emphasis added]. The Applicants are advised to either restructure the claim language so that it only depends from one other claim or to cancel the present claim. As a note of reference, dependent claims 43, 45-53 inherently include limitations of independent claim and are objected to as well. Furthermore the Examiner would like to point out that **claims 42, 43, 45-53 and 59 will not be examined on the merits**.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

- The term "prime polynomial" in claim 2 is a relative term which renders the claim indefinite since it is not defined over any specific field. The term "prime polynomial" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably appraised of the scope of the invention. The Examiner would like to point out that the issue of indefiniteness arises because a "primitive polynomial" is defined over some

field. The claim language does not specify a field. For example the polynomial x2 + x + 1 is irreducible in GF(2)[x], but not in GF(4)[x]. Therefore, in order to overcome this issue, Applicants are advised to specify the field for the prime polynomial in the claim language.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-41, 44 and 56-58 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Turbo Codes: Analysis, Design and Iterative Decoding and Applications** Course 909, by Benedetto et al. further in view of Divsalar et al. (USPN 6023783). As stated above, due to multiple dependencies, claims 42, 43, 45-53 and 59 will not be examined on the merits.

As per claims 1 and 54, Benedetto et al. (herein after: Benedetto) substantially teaches the limitations in claims 1 and 54 of the present application through Figure 3, page 295; Figure 4, page 300 and Figure 8, page 339. For example, Claim 1 of the present application recites: A rate n/n recursive, systematic convolutional encoder which comprises: n inputs, wherein n is an integer greater than 1; n parallel outputs; an adder having (n+1) inputs and an output; and a feedback loop, including one or more storage elements in series, coupled to the output of the adder and to an input thereof, the feedback loop and the one or more storage elements being characterized by a prime polynomial; wherein all n encoder inputs are input to the adder, (n-1) of the encoder inputs are passed through unaltered to form (n-1) of the encoder outputs, and the n^{th} encoder output is derived from the feedback loop. The following figure is imported from Benedetto's reference.

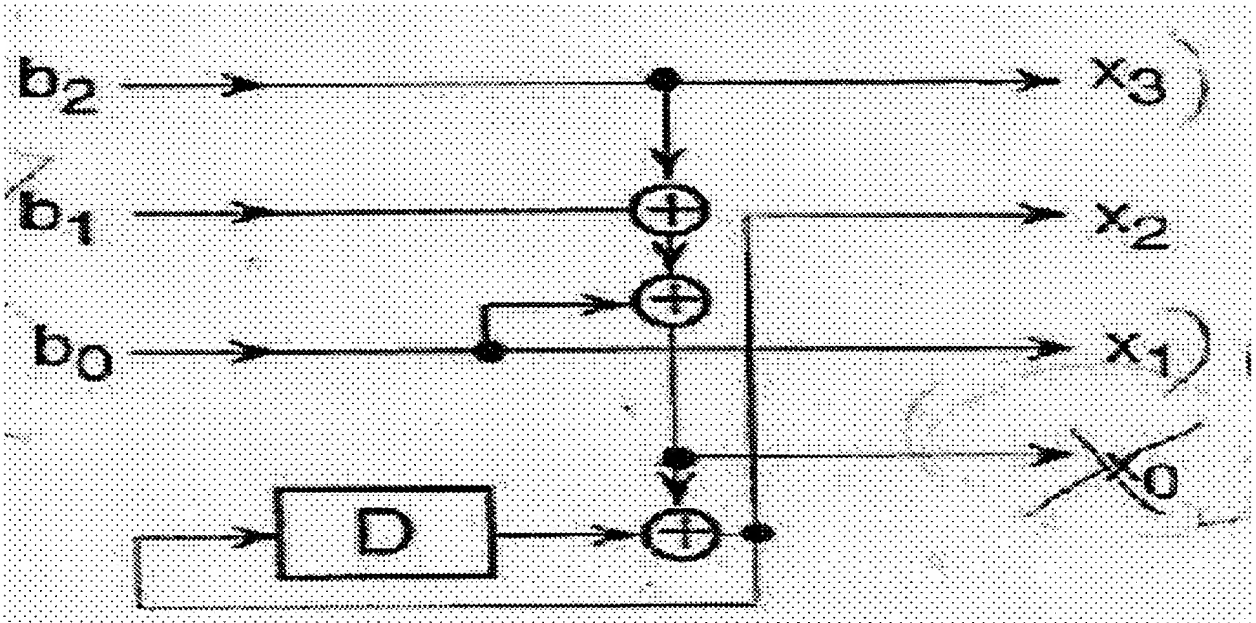

Figure 4, Page 300

The Examiner would like to point out that in the above Figure 4, Benedetto teaches the limitations of claim 1 with slight modification. The following description is in reference to Figure 4 above: The adder connected to the output of the delay element has (n+1) inputs, which are b2, b1, b0 and the output of the adder. The output of the adder in formed in a feedback loop that includes a storage element. Furthermore, two of the three inputs of the encoder are unaltered, namely b2 and b0, whose respective outputs are x3 and x1.

Benedetto does not explicitly teach a rate n/n encoder as stated in the present application. The Examiner would like to point out that it is well know in the art that a rate of an encoder is defined as the ratio of the number of inputs to outputs. The limitation of claim 1 of the present application states a rate n/n, which essentially means that the number of inputs is equal to the number of outputs. Referring to Benedetto's Figure 4 above, one of ordinary skill in at the time the invention was made would have recognized that by eliminating output x0 would indeed have made the above-shown encoder a rate n/n. This modification would have been obvious to one of ordinary skill in the art because one of ordinary skill in the art would have recognized that by eliminating the x0 output of the encoder taught by Benedetto in Figure 4 would have increased the coding gain at relatively low bit error rates. Furthermore, the Examiner would like to add that by removing the x0 output also would have been an obvious design choice and not patentably distinct.

As per claims 2-3, Benedetto substantially teaches, in view of above rejections and Figure 4 above, a feedback loop that includes a single storage element wherein the input of the storage element is coupled to the output of the adder, and the output of the storage element is

coupled to an input of the adder, and the nth encoder output is derived from the output of the storage element.

As per claims 4-8 and 11-19, Benedetto substantially teaches, in view of above rejections, a rate n/n encoder which could be modified to a rate 2/2, 3/3, 4/4, 5/5 or greater. This is an engineering design choice which could easily be modified.

As per claims 9, 10 and 32-35, Divsalar et al. (herein after: Divsalar) in an analogous art teaches (title & abstract) several improved turbo code apparatuses and methods. The Divsalar patent encompasses several classes: A data source is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each encoder outputs a code element which may be transmitted or stored. A parallel decoder provides the ability to decode the code elements to derive the original source information d without use of a received data signal corresponding to d. The output may be coupled to a multilevel trellis-coded modulator (TCM). A data source d is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each of the encoders outputs a code element. In addition, the original data source d is output from the encoder. All of the output elements are coupled to a TCM. At least two data sources are applied to two or more encoders with an interleaver between each source and each of the second and subsequent encoders. The output may be coupled to a TCM. At least two data sources are applied to two or more encoders with at least two interleavers between each source and each of the second and subsequent encoders. At least one data source is applied to one or more serially linked encoders through at least one interleaver. The output may be coupled to a TCM. The invention includes a novel way of terminating a turbo coder. In particular Divsalar substantially teaches (col. 22,

lines 43-67), in view of above rejections, methods that are equivalent to a multidimensional trellis-coded modulation scheme that uses 2.sup.b/2 .times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. With these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation could be redesigned based on the Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21.

As per claims 20-30, 36, 37 and 54-58, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Tellis Code Modulation (TCM). For example, for a q=2 turbo code with rate b/(b+1) constituent encoders, select the b/2 systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the b/(b+1) code (note that the rate b/(b+1) code may have been obtained already by puncturing a rate 1/2 code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use 2.sup.1+b/2 PSK symbols (or 2.sup.1+b/2 QAM symbols) per encoder and achieve throughput of b/2. For M-QAM, we can also use 2.sup.1+b/2 levels in the I-channel and 2.sup.1+b/2 levels in the Q-channel and achieve a throughput of b bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses 2.sup.b/2

.times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation should be redesigned based on the Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations .pi..sub.1 and .pi..sub.2, we used S-random permutations with S=40 and S=32, with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, two 16-state were used, rate 4/5 codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. FIG. 23 is a block diagram of an 8 PSK turbo trellis-coded modulation coder in accordance with the present invention. The Examiner would like to point out that with the combination of the

teachings of Divsalar with Benedetto the various embodiments of the above claims are established.

As per claims 31, 38-41 and 44, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Tellis Code Modulation (TCM). Divsalar teaches FIG. 28, a block diagram showing a general iterative decoder structure for the TCM encoded output of, for example, FIGS. 21, 23, and 25. Furthermore, Divsalar teaches a method to construct Turbo TCM. As stated before, for a q=2 turbo code with rate b/(b+1) constituent encoders, select the b/2 systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the b/(b+1) code (note that the rate b/(b+1) code may have been obtained already by puncturing a rate 1/2 code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use 2.sup.1+b/2 PSK symbols (or 2.sup.1+b/2 QAM symbols) per encoder and achieve throughput of b/2. For M-QAM, we can also use 2.sup.1+b/2 levels in the I-channel and 2.sup.1+b/2 levels in the Q-channel and achieve a throughput of b bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses 2.sup.b/2 .times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. Obviously, the constituent codes for a given modulation should

be redesigned based on the Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations .pi..sub.1 and .pi..sub.2, we used S-random permutations with S=40 and S=32, with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. In FIG. 27, Divsalar teaches a application of a TCM module M in combination with a conventional two-code turbo coder to give the advantages noted above. In addition, such a module M is shown in outline in FIGS. 6 and 7. It should be noted that the structures shown in FIGS. 6, 7, and 27 are general in nature, and provide advantages independent of specific interleavers, coders, and TCM modules.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Benedetto and Divsalar in combination substantially teach the limitations of the

present application. As a note, only Divsalar is included in the PTO 892 since Applicants submitted Benedetto in their IDS and therefore shall have the original copy.

Any inquiries concerning this communication should be directed to the examiner, Mujtaba Chaudry who may be reached at 571-272-3817. The examiner may normally be reached Mon – Thur 6:30 am to 4:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, please contact the examiner's supervisor, Albert DeCady at 571-272-3819.

Mujtaba Chaudry
Art Unit 2133
March 1, 2005

Guy J. Lamarre
Primary Examiner